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The Design of Quadrocopter Contributes to Safety of Aircraft Take-Off &Landing

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***Abstract*—This paper presents information about quadrocopter designed for special aim and its applications. In this context, it focuses basic subjects such as design of a quadrocopter, obtaining numerical data, detection of foreign matter on runway. The measurements and graphs belongs to the subject in point are included. The analyses to be carried out put forward that the quadrocopter has many fields of use contribute to safety of aircraft take-off and landing.**

Keywords—building of qudrocopter, telemetry, video processing

I. Introduction

Air power is one of the concepts whose importance is getting increased in todays. This importance provides for the operating performance and usage areas of both military and civil aerial vehicles to develop and increased rapidly. One of the indicators of the development in point is application of unmanned aerial vehicle has most advantages when compared with manned aerial vehicle. Most of subjects on quadrocopter and aerial vehicles have been dealt with in many different ways. Design and stability analyses for controller [1], the controller of nonlinear dynamic model of quadrotor [2], control of quadrotor for trajectory tracking [3], design of robust flight controller [4], detection of obstacle and junctions [5], aerodynamically and mechanical design of quadrotor [6], altitude estimation [7], a vision based line tracking control [8], a flexible unmanned aerial vehicle for precision agriculture [9], hybrid pose / wrench control framework [10], using a small unmanned aerial vehicle for polar scientific research [11], a new paradigm for construction Special Cubic Structures [12], applications of an electronic compass in micro quadrotor [13], the development of a multi-functional micro air vehicle [14], a real-time vision based algorithm for 5 degrees-of freedom pose estimation and set-point control for MAV [15], building a prototype of autonomous aerial vehicle, specifically designed for applications in cooperative networks [16], perception and control of a micro-UAVs [17], the integration of GPS navigation equipment to a miniature detention mapping receiver system [18], solving problem about formation transmissions from distant targets [19], and using pressurized structures-based (PSB) technologies in aerial vehicles [20] can be given example dealt with topics of the studies on this field. When considering the examples, this paper differs from them in terms of the purpose of construction of. The aim of this project carried out within Anadolu University is to detect conditions of the weather and runway is suitable for flight or not.

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II. Building a Quadrocopter

Generally quadrocopter can be built in two modes and they have advantages and disadvantages when compared with each other. One of them is "+" mode and the other one is "x" mode. The main differences between them are the number of rotors meets the desired movements. "+" mode meets them one rotor, but "x" mode meets two rotors. In this project, X type has been built so desired availability has been obtained (Figure 1).

Figure 1. *X type of quadrocopter*

In building quadrocopter, many different mechanical and electronic components have been used (Figure 2).

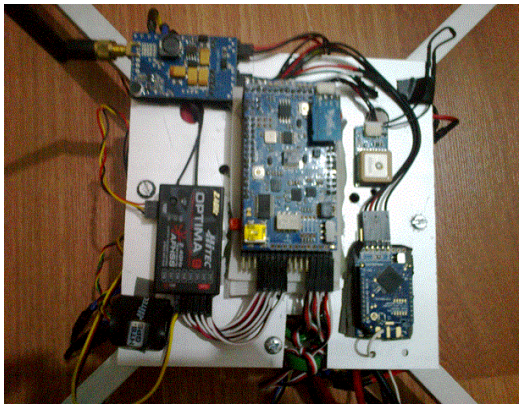

Figure 2. *Electronic componenets*

The component to be used in this project can be listed as brushless motor, ESC (electronic speed controller), the transmitter and receiver of remote control device, xbee, FPV (flight person view), GPS, Ardupilot Mega control devices, IMU (Inertial Measurement Unit).

Brushless motor divides into two categories as type of inrunner and outrunner. Because the outrunner type produces more torque in lover speed than inrunner type, the outrunner type has been preferred in this project. The ESC is a motor drive component to be used in outrunner type brushless motor. It uses the technique of PWM and includes 5V regulator named as BEC (battery eliminator circuit). BEC provides to feeding control card and the receiver of remote control device. The remote control device to be used is 2.4 Ghz AURORA 9 has nine channels and property of monitoring information about telemetry on the screen. Xbee module is used for RF telecommunication. The system of 5.8 GHz FPV to be used transporting image data forms the units of transmitter and receiver. Because this is civil application, GPS to be used for detection of location utilizes 1575.42 Mhz - 227.60 Mhz bandwidth. For the control of quadrocopter, Ardupilot Mega control card has been used and it is main control card of it. Also it utilizes the data obtained from receiver of the remote control device, IMU and external sensors as inputs. According to the in points at issue, it sends signals of PWM to the component of ESC and provides controlling of quadrocopter. IMU is a part where the sensors produce the data that the system of control needs. Three axes gyroscope and accelerometer, the sensors of pressure and temperature, 16 Mbit data recording chip, and connection ports for additional sensors are available on the IMU.

III. *Measurement of Air Conditions and Detection of Foreign Matter*

This project has been carried out within Anadolu University has own airport Anadolu Airport. Anadolu Airport is served both commercial and civil training flight. Especially during training flights, for environmental factors to be monitored and recorded is needed for increasing performance of taking off and landing because the training aircrafts haven't got hi-tech systems.

There are many factors effect on operating performance of aerial vehicles. Altitude, air density, pressure, temperature, and dam are one of the factors at issue. And also all of them are in relation each other. When altitude increases, pressure and density of air reduce. Such condition is effective on thrust directly. Because of this, for the factors in point to be in desired limits and to be measured correctly are of great importance in terms of operating performance of a quadrocopter. In this context, measurement of temperatures and RPM (revolution per minutes) values are presented in this part of the paper. Additionally, for the data to be monitored on the screen of remote control device is shown (Figure 3).

Figure 3. *The the remote control device's screen relating the sensors*

The temperature of air and rotors can be monitored and recorded via the designed quadrocopter. For measuring of them, sensor of HTS-TEMP located on the telemetry system has been used (Figure 4).

Figure 4. *HTS-TEMP sensor*

It has capacity of measuring between -40 °C and 200 °C so it enables to measuring of temperature in point in different altitudes. The data obtained from the sensors are transported to both remote control device via the telemetry system and grand computer via xbee (Figure 5).

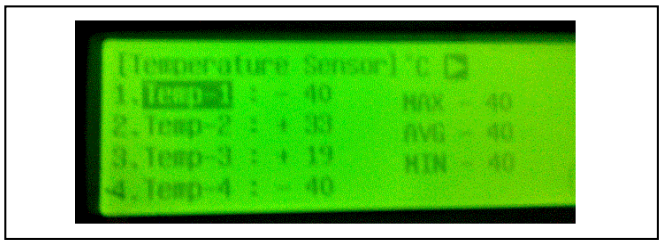

Figure 5. *Monitoring of HTS-TEMP sensor* data *on remote control device*

Temperature sensor has four outputs Temp-1, Temp-2, Temp-3 and Temp-4 as shown in Figure 5. In this project only Temp-2 and Temp-3 ports has been used. Temp-2 port refers to temperature of air and Temp-3 port refers to temperature of rotor. The other ones refer to minimum scale of the sensor. The measurement shown in Figure-5 carried out on April 20, 2013 in Eskisehir, Turkey.

Obtained data via HTS-TEMP sensor are plotted with MATLAB and its graph is shown in Figure 6 and Figure 7.

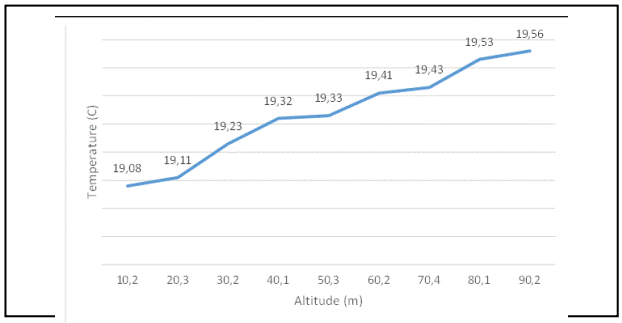

Figure 6. *The graph of air temperature data*

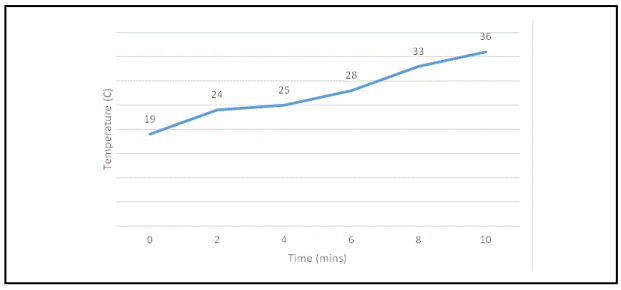

Figure 7. *The graph of rotor temperature data*

For the measuring of rotor RPM, HTS-ORPM located on the body of quadrotor to see the propeller (Figure 8).

Figure 8. *HTS-ORPM sensor*

When looking the figures from 3 to 8, it can be said that they are divided into three categories location of sensor, appearance on the screen and graph of data. Figure 4 and 8 show location of the sensor, Figure 3 and 5 represents appearance of the data on the screen of remote control devices, and Figure 6 and 7 demonstrates the graphs of the obtained data via the sensors.

IV. Detection of Foreign Matter

Detection of foreign matter is a critical subject in aviation field as in many fields. The foreign matter on the runway can be serious problems as in the systems of oiling, air or fuel. Whereas foreign matters led to problems such as damage of flow or components of system etc. in the systems, it brings about matters such as stopping the motors, reducing maneuver capacity. According to all of aforesaid reasons, it is necessary for foreign matters to be monitored and recorded. In this part of the paper, the measurements and analyses aiming at determination of foreign matter on runways are presented.

For detection of foreign matters, FPV system is used. The quadrocopter flights by scanning the area. Firstly, obtained data is transported to ground computer (Figure 9).

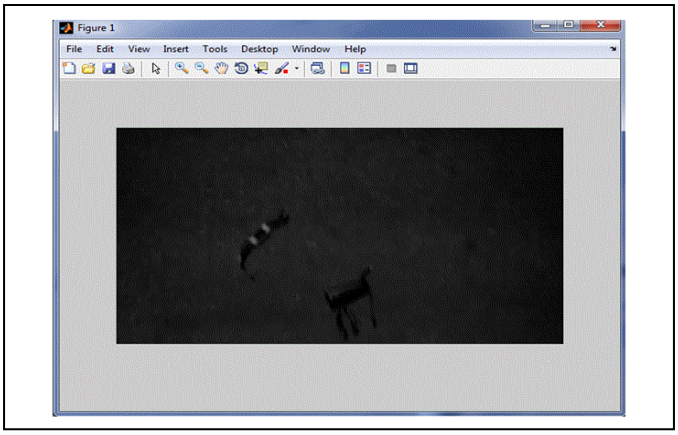

Figure 9. *Obtained data via FPV system*

After the transporting, the data are processed via MATLAB (Figure 10), so it is enabled for the foreign matters on runway to be detected (Figure 11).

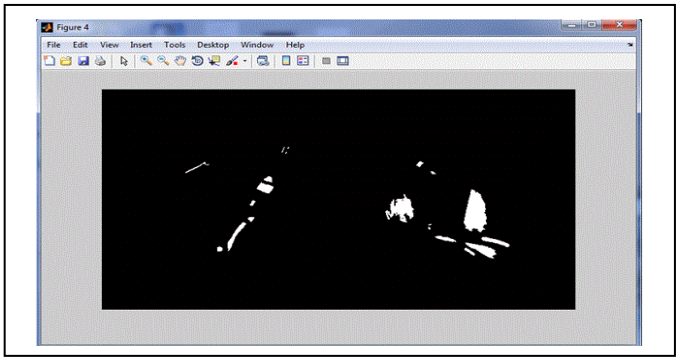

Figure 10. *Processed data via MATLAB*

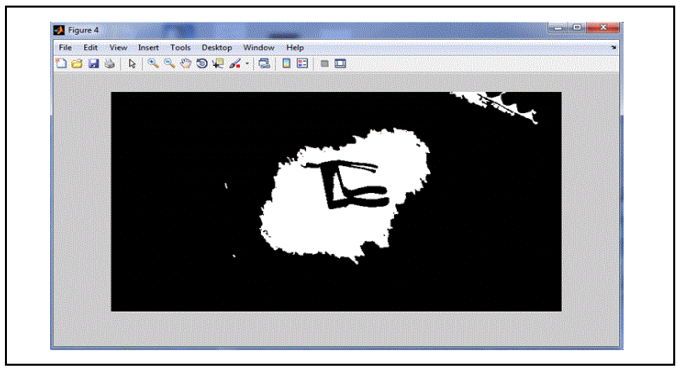

Figure 11. *Detected matter*

There is an important point is that the detection includes all color foreign matter other than gray tons.

v. Results and Conclusion

This project focuses building of a quadrotor for special task. For this aim, x type quadrotor has been built and equipped many features, but this paper is focused only measuring temperature of air and rotor and RPM value of a rotor.

Air condition and parameters of rotor are critical points in terms of operating performance of the vehicle, so their monitoring, recording, processing and controlling are of great importance. In this context, this paper presents information about such parameters temperature of air, temperature of rotor and RPM of the rotor.

The parameters at issue has been monitored and processed for contributing safety of training flights to be carried out in Anadolu Airport. The airport has been used for both commercial and civil flights. Before the each flight, for the conditions of air, rotor and runway to be controlled with quadrocopter is aimed in this project. This application contributes the safety of flight.

For the data to be obtained by using a quadrotor provides many advantages. Time saving, more detailed screen, more sensitive measurements can be given as examples of the advantages at issue. Needless to say, most of the aircraft crashes or problems result from the human factor. In this sence, it is clearly said that using quadrocopter vanishes the human factor. This situation provides for more reliable measurements to be had.

When evaluating the detection of foreign matter process, it is saw that this application is successful. For the application to be carried out in a short time, with high accuracy and without human factor is of great importance.

When considering this paper as a whole, this paper puts forward building a quadrocopter and its application areas. Because it is equipped with many features, it is enable obtaining many different data. It means that is can be used for many different tasks. With respect to the both desired aims are achieved and new application areas has been emerged.

Acknowledgment

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